IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION

EXPANDED FUNCTIONALITY PROTOCOL ADAPTER FOR IN-VEHICLE NETWORKS

Docket No. DGI-105-A

Cross-reference to Related Application

This application is based on Provisional Patent Application Serial Number 60/229,008 filed August 30, 2001.

Background of the Invention

The field of the invention pertains to in-vehicle networks for diagnostics, analysis and monitoring. The networks integrate with PC gateways for data acquisition, computer-based measurement, and automation systems with in-vehicle communication. However, in the past, when hardware components were upgraded, existing software could become non-compatible with the upgraded hardware. Manufacturers of various tools attempted to remedy these compatibility problems by using a box to talk to multiple data links. This was not very satisfactory and a better solution to this problem was needed.

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Summary of the Invention

The invention is an expanded protocol adapter for in-vehicle use. The protocol adapter of the invention is a diagnostic tool that can bridge a lap-top or bench-top or other computer to a vehicle network. The expanded protocol adapter has additional capabilities beyond earlier versions. It is advantageous for research and development applications, end of line testing and design and production applications such as quality control, life-cycle testing and burn-in applications. The protocol adapter of the invention solves the above-identified problem by operating as a translator box that works with a variety of software packages. Thus, the invention is operable with existing diagnostic software packages.

The expanded protocol adapter of the invention supports the following:

SAE J1850, GM Class 2 protocol;

SAE J1850, Chrysler protocol (future activation supported);

GM Class 1 UART (ALDL) protocol;

ISO 9141-2 protocol;

ISO 9141-1989 protocol;

ISO 9141-Special protocol (for Case Corp.);

SAE J2284, Dual-wire CAN protocol; and

SAE J2411, Single Wire CAN protocol (future activation supported).

A special pass-through mode allows users to continue utilizing yesterday's in-house software, while communicating with today's hardware. Older software packages such as RP1202 and RP1210 can still be employed. This feature allows users to replace aging hardware with an interface that can support existing software. Consequently, users can replace old hardware with the invention and yet maintain computability with their original software.

The earlier protocol adapter supported SAE J1708, SAE J1939, and Control-Area (CAN) networks. The earlier adapter has a voltage converter mode that supports RS-232-to-RS-485 voltage conversion. The normal RS-232 port allows direct access to the J1708 / RS-485 link. The improved protocol adapter supports the listed prior protocol adapter features, including a library (DLL/VxD for Windows) and on-board flash for field upgrades. The improved protocol adapter also employs a pass-through mode which supports communication with "old" software packages (e.g. RP1202 and RP1210(A).

The improved protocol adapter of the invention expands functionality and usage of the earlier protocol adapter and can be used with a half-slot ISA card or in a PC-104 card version.

The improved protocol adapter employs expanded use of LED's to indicate status of the device, which mode of operation, and if in communication. Dual color LED's are used to indicate which program is being executed by the protocol adapter. The pass-

through ability to emulate other protocol adapters is indicated by a dual color LED to indicate the pass-through is functioning to emulate other protocol adapters. Beyond the normal use of LEDs, eight visual indicators are employed by this protocol adapter. The eight visual indicators are four dual-color LEDs (red and green). Three of the dual-color LEDs serve to notify the user which one of the six, user-selectable protocols is in use at any given time. The fourth dual-color LED indicates the mode of operation for the this protocol adapter, the DPA III Plus, referred to as "DPA" for normal mode(red) or "PASS" for pass-through mode (green). While operating in the pass-through mode, the protocol adapter additionally supports communications with various "older" software packages, such as RP 1202 or RP1210, whereas in the normal mode, such additional support is not provided. Alternating red/green indicates reflash (reprogramming) is in progress.

The status of the LEDs indicate to the user the mode of operation for the device and which of the various protocols is currently active. The meaning of the LED indicator status will be described hereinbelow.

It should be noted that earlier protocol adapters support communications with "older" protocols, but earlier protocol adapters do not provide an indication to the user as to which mode is being used (normal or pass-through).

Earlier protocol adapters used a single color LED that could only notify that there is RS232 bus activity between the device and the PC. The protocol adapter of the invention uses an LED in the same physical location, but a dual-color LED allows indication of which mode is being used. A red LED is used to indicate when power is applied to the unit.

This adapter incorporates additional functionality of supporting the use of Dearborn Programmable Bridge (DPB) software. Compatibility with the DPB allows this adapter to support translation of messages between any of the protocols currently in use, e.g., SAE J1939 to J1708. The addition of DPB capabilities is integrated into the functionality of the adapter is such a manner as the make the inclusion of support for these added capabilities transparent to the user.

The adapter provides rapid access to any supported network by allowing the user to easily switch between protocols. This rapid access affords the user with the ability to monitor and translate messages between different protocols at the same time.

An ISA, half-card version and a PC-104 version of the protocol adapter provide most of the functionality as described herein except for two functions. The two functions not supported by the ISA half-card version and the PC-104 version of the protocol adapter are pass-through mode of operation and Dearborn Programmable Bridge (DPB) software compatibility.

The protocol adapter of the invention has reflashing that allows the protocol adapter to be updated with new firmware in the field. This is accomplished by U5, U1, U8 and U4. U5 (micro) processes a command sent to the protocol adapter by the host. It then copies the reflash instructions set (loader program) into RAM (U1) and then transfers control to that program (loader). The loader program responds to the commands from the host which allows the host computer to then clear and reprogram the Flash (U4). Once the reproming is complete control is passed back to the flash program.

The protocol adapter of the invention has status lights that allow the operator to determine what program is being executed by protocol adapter embedded micro. U5 and U10 will flash the LEDs on the I/O board in a predefined manner at power up to indicate what version of firmware is being executed.

The invention has a pass through feature (voltage translator) / smart mode that allows the protocol adapter to emulate older boxes. In this mode of operation, the U5 (micro) delivers data directly from the J1708 Transceiver (U11 of I/O board) to the RS232 transceiver (U7 of I/O board) and monitors the data to provide J1708 defined timing signals on any or all of the RS232 hardware handshake lines.

The expanded protocol adapter can be used wirelessly to perform the following functions; ECU fault code interrogation; communication with a remote network; vehicle maintenance status checks or trip performance data downloads; and improved asset

control, logistics and inventory management, diagnostic support, and maintenance / scheduling.

An ISA version of the improved protocol adapter is a half slot card that supports CAN (J1939 and DeviceNet), SAE J1850, and GM UART protocols.

The protocol adapter has additional unique features of bank switching, file upgrade capability, LED status, multiple datalinks, embedded versions, programmable manufacture's name, software locks, async transmit and receive, programmable timer and a scratch pad.

For bank switching, memory is swapped in and out of the processor's memory map to allow multiple programs to be run. For field upgrade capability, non-volatile memory can be programmed in the field to allow new software features to be added in the field. For LED status, LEDs are flashed in a unique sequence at power-up to indicate what version of firmware is being executed. Multiple data link may be supported at the same time. Firmware and hardware version numbers are available to the host to allow the host to determine current capabilities. The manufacturer's name is embedded in FLASH to allow VAR's to put in the name of the VAR's company.

Proprietary software lock/key may be burned into FLASH to allow use of the VAR's software. The device is capable of receiving and transmitting asynchronously of host processor and can broadcast on transmit and filter on receive.

The device has a programmable multi-function timer to support datalink communications. The scratch pad is a built-in remote access memory to allow the host to consolidate message data.

Features of the improved protocol adapter are support for RP1202 and RP1210, J1708 and J1939, J1939 Transport Layer. The improved protocol adapter has a Real Time Clock, Standard COMM port connection, 7-32 Volt Supply and is CE compliant.

Brief Description of the Drawings

FIG. 1 illustrates DPA III Plus CPU board;

FIG. 2 illustrates CPU Memory Module;

FIG. 3 illustrates Central Processing Unit;

FIG. 4 illustrates Device Decoder;

FIG. 5 illustrates static RAM Module;

FIG. 6 illustrates Flash Memory Module;

FIG. 7 illustrates UART;

FIG. 8 illustrates CPU/ I/O Interface Connectors;

FIG. 9 illustrates Discrete Output Latch;

FIG. 10 illustrate Unused Spare Gates;

FIG. 11 illustrate DPA I/O Board;

FIG. 12 illustrates I/O Interface Connector;

FIG. 13 illustrates RS-232 Transceivers;

FIG. 14 illustrates Power Supply Regulator;

FIG. 15 illustrates 1708 Transceiver;

FIG. 16 illustrates J1850 Transceiver;

FIG. 17 illustrates LED Indicators;

FIG. 18 illustrates CAN Transceiver;

FIG. 19 illustrates ATEC to J1708 Bridge;

FIG. 20 illustrates Unused Gates;

FIG. 21 illustrates LED No. 1 description;

FIG. 22 illustrates LED No. 2 description;

FIG. 23 illustrates LED No. 3 description;

FIG. 24 illustrates LED No. 4 description;

FIG. 25 illustrates LED No. 5 description; and

FIG. 26 illustrates LED layout diagram.

Description of the Preferred Embodiments

Now turning to the drawings, the circuits of the protocol adapter are thereshown in FIGs. 1 through 20.

The pass through/ smart mode is U11 (shown on FIG. 8) and is controlled by U5 (shown on FIG. 3) to determine if the host PC is listening to the J1708 link, or if the host PC is wanting to have a slave session with the DPA (diagnostic tool).

The U5 micro (FIG. 3) at power up will flash LEDs 2, 3, 4, and 5 (FIG. 26) to allow the operator to know what version of

software is running inside the protocol adapter or diagnostic tool (DPA).

Now turning to FIGs. 21 through 25, the LED descriptions are thereshown with the LED diagram shown in FIG. 26.

EDGE DETECTION